thermostat at 40° with saliva, no reduction. Iodopotassium iodide, no color change or precipitate. Tannic acid, negative. Murexide test, negative. Biuret test, negative. Lead acetate, white flocculent precipitate on warming.

Analysis of the filtrate for nitrogen and ash: 25 c.c. of solution evaporated and dried at 110° gave 0.0324 gram of residue. Substance gave on ignition 0.0116 gram of ash = 35.8 per cent. Nitrogen in dried residue = 11.7 per cent. = 18.2 per cent. in ash-free substance.

The animal charcoal was extracted with ammoniacal 50 per cent. alcohol. A thick brown liquid was obtained, which with zinc and hydrochloric acid evolved hydrogen sulphide.

In regard to the nitrogenous carbohydrate of Salkowski, it will be seen that we have not been able to confirm his results. While the presence of a carbohydrate group is possible from the faint Molisch test which we obtained, this test is too delicate to conclude that the substance is really a definite part of the colloidal nitrogen. As far as a reducing carbohydrate, which is to be obtained after inversion, is concerned, the tests which were designed to show its presence absolutely failed.

SUMMARY. The colloidal nitrogen of Salkowski does not bear any relation to the undetermined nitrogen. The method cannot be recommended for clinical use. In the mixture precipitated by alcohol from urine the nitrogenous carbohydrate described by Salkowski was not found.

A COMPARATIVE STUDY OF THE OCCULT BLOOD TESTS; A NEW MODIFICATION OF THE GUAIAC REACTION; ITS VALUE IN LEGAL MEDICINE.

By David Murray Cowie, M.D.,
INSTRUCTOR IN PEDIATRICS, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN.

(From the Clinical Laboratory of Internal Medicine, University of Michigan.)

Occult blood reactions, chemical reactions for the recognition of minimal hemorrhages into the gastrointestinal tract unrecognizable by the unaided eye, have been the subject of considerable discussion among internists during the last two or three years. It has been but a very short time since much stress has been laid upon the value in the differential diagnosis of gastrointestinal diseases of the recognition of these minimal hemorrhages. Our present knowledge of the subject may be said to date from the appearance of Boas' first article.[1] So little attention was given to this that in his second article which appeared a year later, he expresses surprise that clinicians have neglected what he considers a great advance in our clinical knowledge of these diseases. Practically two years passed before the work was seriously taken up by others, and then followed contributions from Schmilinsky,[2] Joachim, Schloss,[3] Hartmann,[4] Clemm,[5] and a few others, all of whom reassure us of the value of these tests. The history of the original Weber[6] reaction has been one of repeated modifications and a changing of the conception of what is and what is not a proper end reaction.

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[1] Sammlung klin. Vorträge, February, 1905, Nr. 387. (Many other references.)

The tests fortunately are very simple, but experience has taught us that this simplicity must be conducted with decided care, particularly in experimental work. Weber's test and all of its modifications depend upon three definite principles: (1) That changed hemoglobin is soluble in acetic acid, forming acid hematin; (2) that acetic acid solutions of hematin are soluble in sulphuric ether; and (3) that guaiac resin when dissolved and ozonized in a solution of blood causes a typical color reaction. I give herewith the original Weber test and its most important modifications, as well as the Klunge aloin test. For convenience the successive steps in each test have been numbered.

Weber's Test. 1. Five c.c. of stomach contents or a similar amount of softened stool is mixed with one-third its amount of glacial acetic acid.

2. To the above mixture add an excess of ether and allow to extract.

3. To a portion of the resulting extract add ten drops of a freshly prepared tincture of guaiac, and shake thoroughly.

4. Add thirty drops of old turpentine.

If the reaction is positive an intense blue color results. If there is much blood present the ether extract becomes a Tokay color. If there is little blood the ether remains uncolored.

Boas' First Modification of the Weber Test. 1. About 5 c.c. of soft stool is extracted with 20 c.c. of ether to remove the fats.

2. Pour off the resulting extract.

3. Add 2 or 3 c.c. of glacial acetic acid to the remaining stool, and mix thoroughly.

4. Extract with 10 c.c. of ether.

5. Add a few granules of powdered guaiac resin to a portion of the above extract in a test-tube and shake carefully.

6. Add thirty drops of old turpentine.

The main difference is that Boas first extracts with ether to remove the fats that may be present and employs the powdered guaiac in place of the tincture.

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[2] Münch. med. Woch., 1903, Nr. 49.

[3] Arch. f. Verdauungskrankheiten, Band x, Heft 3.

[4] Ibid., Band x, Heft 1.

[5] Ibid., Band x, Heft 4.

[6] Berl. klin. Woch., 1893. No. 19.

Boas' Second Modification of the Weber Test. Instead of using old turpentine Boas later recommended the use of dilute hydrogen peroxide—a 3 to 5 per cent. solution. He was then of the opinion that it was not necessary first to remove the fats, and this part of the test was dispensed with. Boas found this method more delicate than the turpentine method.

Rossel advises that when the test is applied to the stomach fluid it should first be neutralized. Boas claims that neutralization is not necessary. This is very easy to demonstrate.

Author's Water Modification. 1. All glassware must be chemically clean and perfectly dry.[7]

2. To one gram of stool which has been softened if necessary by as few drops of water as possible, about 4 or 5 c.c. of glacial acetic acid is added and intimately mixed. This is best accomplished by rubbing up in a glass mortar.

3. To the above mixture add 30 c.c. of ether and allow to extract for several minutes, after thoroughly shaking or mixing.

4. To 1 or 2 c.c. of the extract, which is perfectly clear and can be decanted off, add an equal amount of distilled water and shake thoroughly.

5. To the resulting mixture add a few granules of powdered guaiac resin, an amount that will be held on the tip of a small knife-blade; this is allowed to dissolve and the tube is agitated thoroughly.

6. Thirty drops of old water-white chemically pure turpentine is now added, and thoroughly mixed with the contents of the tube. Set aside against the light or in front of a white surface.

If blood is present to the amount of 1 milligram to 1 gram of stool a distinct light-blue color develops quickly in the upper half of the mixture, remains for a short time, and gradually disappears. Larger amounts of blood cause a more intense blue, but almost always a turbid, or opaque blue, often the color of a turquoise.

NOTE.—If the reaction is intense it may be better seen if about 10 c.c. of ether is added to the original extract. If smaller amounts of blood are present the reaction may assume a smoky grass-green color. (See later.) The reaction may be sometimes intensified by extracting the greater part of the coloring matter with alcohol which may be filtered off. This makes the test long and it is seldom necessary.

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[7] The precaution of absolute dryness is not necessary if comparatively large amounts of blood are present. My assistant, Dr. Roche, obtained a positive blue in the early morning several times by the author's method. Other methods were negative. I was unable to verify the results at 11 A.M., neither could Dr. Roche. We then sought for an explanation. Fearing that the early morning positive reaction was due to contamination of the tubes they were all washed with nitrohydrochloric acid and thoroughly rinsed in distilled water. No reaction occurred in these tubes An old tube that had not been used and which did not look clean was now used and a beautiful blue reaction occurred. New tubes that had not been unwrapped also permitted the reaction to take place. We repeated this experiment many times, always obtaining a reaction in a perfectly dry tube, never obtaining it in a damp tube. The other modifications did not take place in the dry tubes. From this time on a set of tubes was kept thoroughly dry by draining over night and heating in the oven if necessary. The reason for the reaction occurring in the early morning was due to the fact that the tubes had dried over night.

Several other modifications might be mentioned, but on careful perusal they will be found to be unintentional modifications, due to a misconception of the successive steps of the original reaction; when applied to very minute amounts of blood they do not react. As the re-extraction with ether has been shown by Boas and others, and can be easily demonstrated, to be of no importance, it is omitted in the experiments that follow; the difference between the two tests being simply in the oxidizing agent employed. Other variations that have been made are noted.

Aloin Test. Klunge has introduced what is known as the aloin test, the successive steps of which are as follows, the principle of the reaction being the same as the guaiac reaction:

To the acetic acid and ether extract obtained as above, 20 to 30 drops of ozonized turpentine is added. The resulting mixture is now treated with from 10 to 15 drops of a freshly prepared tincture of aloin. (About 3 grains to 5 c.c. of 70 per cent. alcohol.) If blood is present, a beautiful cherry-red color gradually develops, but sometimes requires many minutes. By adding a few drops of chloroform the color change may be hastened and intensified. The cherry-red color usually develops in the bottom layer, which is the aloin layer. At other times the entire contents of the tube are changed to a pink or light cherry color. A contact test results if the aloin solution is allowed to run down the side of the tube. A slight pink color will often develop in an hour's time in the absence of blood. The reaction should occur within one-half hour to be positive. Boas employs this test as confirmatory of the guaiac test. He thinks that at times it is more sensitive than the guaiac test.

EXPERIMENTS.

Series I.—Meat Diet Investigations.

It has been claimed that reactions for occult blood occur in the stools of individuals eating a meat diet, and that for this reason the test should be applied only when the patient is eating a meat-free diet. The purpose of this experiment is, therefore, to inquire into the frequency with which the reactions do occur with the ordinary meal. To this end patients were selected without any reference to their ailment; they were eating the regular hospital diet, which consists of meat at least twice and often three times daily. In an institution where hundreds are being fed the meat is not always thoroughly cooked, that is, rare meat is commonly seen. The conditions, accordingly are well adapted for this experiment.

In all, the stools of thirty-four patients were examined. The consistency varied from partly formed to those containing hard and dry cylinders. In only two cases were positive results obtained (Cases II and XX). Inquiry disclosed the fact that Case II had had a visible hemorrhage the previous day, and Case XX, in whom there had been no suspicion of hemorrhage, was found on subsequent examination to have postnasal conditions which caused a more or less constant oozing into the digestive tract.

Both the guaiac and the aloin tests were made in each case. The experiment illustrates that the tests are not delicate enough to recognize the small amounts of blood that are swallowed with the uncooked portions of the meat. It can be said that individuals on an ordinary meat diet seldom if ever give a reaction for occult blood, and that if a reaction occurs it is in all probability due to some pathological process in connection with the gastrointestinal canal. In this series the ether extract was very little influenced by the color of the stool.

Since the above tests were made we have tested a large number of stools of patients under the same conditions, and have yet to find a positive reaction due to uncooked meat.

Series II.—Meat Ingestion Experiments.

The following experiments were made in order to gain some idea of the amount of uncooked red meat that must be ingested before a reaction for occult blood can be obtained in the stools, and also to determine the length of time after the ingestion of the meat before the reaction appears and disappears. The meat was prepared by scraping round steak and chopping into it a very small amount of onion, pepper, and salt. No fiber was present. The amounts were weighed on the ordinary laboratory balance, and are of course only approximate, yet are fairly accurate. The method that has been found the most delicate is the one that is recorded.

Experiment 1.—Mrs. G. 50 grams of scraped beef was given at 11 A.M.; first stool passed in twenty-one hours; water, guaiac, turpentine method was positive; Klunge test was negative. Second stool was not saved.

Experiment 2.—50 grams of scraped beef was given at 11 A.M. First stool passed in twenty hours; water, guaiac, turpentine method was positive; Klunge aloin test was negative. Second stool passed in forty-two hours; water, guaiac, turpentine method was negative; Klunge aloin test was negative. Third stool passed in seventy-two hours; water, guaiac, turpentine method was negative; Klunge test was negative.

Experiment 3.—40 grams of scraped beef was given at 11 A.M. First stool passed in twenty-one and a half hours; water, guaiac, turpentine method was positive; Klunge test was negative. Second stool passed in forty hours; water, guaiac, turpentine method, and Klunge test were negative. Third stool passed in seventy hours; all tests were negative.

Experiment 4.—Mrs. E. 30 grams of scraped beef was given at 11 A.M. First stool passed in twenty-one hours; water, guaiac, turpentine method was positive; Klunge aloin test was negative. Second stool passed in seventy hours; water, guaiac, turpentine method, and Klunge test were negative.

Experiment 5.—Mr. E. 20 grams of scraped beef was given at 11 A.M. First stool passed in ten hours; water, guaiac, turpentine method was positive;[8] Klunge aloin test was negative.

Experiment 6.—Mr. D. 15 grams of scraped beef was given at 11 A.M. First stool passed in twenty hours; water, guaiac, turpentine method was questionable; Klunge aloin test was negative.

Experiment 7.—Mrs. G. 10 grams of scraped beef was given at 11 A.M. First stool passed in nine and a half hours; water, guaiac, turpentine method was negative; Klunge aloin test was negative. Second stool passed in twenty-four hours; water, guaiac, turpentine method, and Klunge test were negative.

Experiment 8.—Mr H. Stomach was thoroughly washed and drained. At 11 A.M. 10 grams of chopped beef was given. The first stool was passed in eighteen hours. Hard, brownish-green cylinders one inch in diameter, with no visible blood. Extract, water, guaiac, turpentine method, change to blue-green which faded; extract, guaiac, turpentine method was negative; extract, guaiac, dilute H_2O_2 method, black reaction in upper layer; extract, guaiac, strong H_2O_2 method, black reaction in upper layer. Klunge test gave a positive red in the bottom of the tube in a very few minutes.

Experiment 9.—Miss S. was given 10 grams of chopped beef. The first stool was passed in twenty-nine hours, yellowish-brown, semisolid. Extract, water, guaiac, turpentine method quick change to light green deepening to grass-green with no blue; extract, guaiac, turpentine method, no reaction; extract, guaiac, dilute H_2O_2 method, a brownish reaction in upper layer; extract, guaiac, strong H_2O_2 method, a black reaction in the upper layer. Klunge test gave a reddish-brown reaction intensified by chloroform. Second stool passed on the following day. Extract, water, guaiac, turpentine method, quick change to light green which gradually deepened and faded with no blue; extract, guaiac, dilute H_2O_2 method, no change; extract, guaiac, strong H_2O_2 method, plum-color reaction which did not fade in two hours; extract, guaiac, turpentine method, no change. Klunge test was absolutely negative after half an hour.

Experiment 10.—Mrs. J. Stomach was washed and thoroughly drained. 10 grams of chopped beef was given at 11.45 A.M. First stool was passed in eighteen hours, yellowish-brown dry cylinders; all tests were negative. Second stool was not saved.

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[8] A grass-green color quickly appears, this intensifies to a deep green, and very gradually fades away.

CONCLUSIONS. 1. In order that a positive reaction for occult blood be obtained after eating uncooked meat there must have been ingested 10 grams of beef. The smallest amount to give a distinct blue reaction with the guaiac tests was 20 grams. Of five tests below 20 grams the reaction was positive twice, negative three times.

2. The reaction if positive always occurs in the first stool passed after eating the test meal. This occurred in one case as early as ten hours, in another as late as twenty-nine hours. Only once did it occur with the second stool and never with the third stool.

3. The water modification of the guaiac test gives the most uniform results. Both hydrogen peroxide methods and Klunge's test were at times as sensitive as the water modification. The Boas reaction with turpentine is far less sensitive than any of the others. I have been unable after many trials to obtain a reaction with less than 10 grams of beef. Weber reports positive results with 3 grams of meat.

Series III.—Blood and Stool Mixture Experiments.

The purpose of this series of experiments was to determine the sensitiveness of the guaiac and the aloin tests. A definite amount of blood was added to a definite amount of stool. The quantity in each was determined by exact weight. The first three experiments were conducted by calibrating a capillary tube so that the weight of each drop would correspond. Fearing that this was not as accurate as it should be the remaining tests were made by determining exactly the weight of the blood on a very delicate balance with agate bearings and the exclusion of currents of air. The blood in each experiment was always taken from the same person. It was found that in the cases in which the calibrated tube was employed a drop of blood from one person differed in weight from that of another person, but corresponded quite closely with another drop from the same person. For this reason more than one experiment was necessary in order that definite conclusions could be reached.

EXPERIMENT 1.—Drop method. 0.005 gram of blood was added to 1 gram of feces; guaiac, turpentine method was negative; Klunge aloin test was negative. 0.010 gram of blood was added to 1 gram of feces; guaiac, turpentine method was negative; Klunge aloin test was negative. 0.015 gram of blood was added to 1 gram of feces; guaiac, turpentine method was negative; Klunge aloin test was negative. 0.020 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a distinct greenish color; Klunge aloin test gave a distinct but light cherry color. 0.025 gram of blood was added to 1 gram of stool; guaiac, turpentine method gave a distinct blue color; Klunge aloin test gave a distinct but light cherry color.

Experiment 2.—Drop method. 0.005 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a light greenish tinge; Klunge aloin test gave a questionable pinkiness. 0.010 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a light greenish color; Klunge aloin test gave a very slight pinkiness. 0.015 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a questionable color change; Klunge aloin test was questionable. 0.020 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a positive blue color; Klunge aloin test gave a positive cherry. 0.025 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a positive blue to purple; Klunge aloin test gave a very positive cherry.

Experiment 3.—Drop method. 0.005 gram of blood was added to 1 gram of feces; guaiac, turpentine method was negative; Klunge aloin test was negative. 0.010 gram of blood was added to 1 gram of feces; guaiac, turpentine method was negative; Klunge aloin test was negative. 0.015 gram of blood was added to 1 gram of feces; guaiac, turpentine method gave a greenish tinge, positive; aloin test was questionably negative. 0.020 gram of blood was added to 1 gram of feces; guaiac, turpentine method, which gave a distinct pale green, was positive; Klunge aloin test was questionably negative. 0.025 gram of blood was added to 1 gram of feces; guaiac, turpentine method, distinct blue to purple, was positive; Klunge aloin test, distinct but light cherry, was positive.

Experiment 4.—Exact weight method. 0.002 gram of blood was added to 1 gram of feces; guaiac, turpentine method, no change in color, was negative; Klunge aloin test, no change in color, was negative. 0.003 gram of blood was added to 1 gram of feces; guaiac, turpentine method, no change in color, was negative; Klunge aloin test, no change in color, was negative. 0.004 gram of blood was added to 1 gram of feces; guaiac, turpentine method, light greenish tinge, which faded, was positive; Klunge aloin test, upper portion of tube opalescent, was questionable. 0.005 gram of blood was added to 1 gram of feces; guaiac, turpentine method, light greenish tinge, which faded, was positive; Klunge aloin test, upper portion of tube pinkish, was questionable. 0.006 gram of blood was added to 1 gram of feces; guaiac, turpentine method, distinct light green, which faded, was positive; Klunge aloin test was questionable. 0.007 gram of blood was added to 1 gram of feces; guaiac, turpentine method, distinctly deeper green, which faded, was positive; Klunge aloin test, same as before, was questionable. 0.008 gram of blood was added to 1 gram of feces; guaiac, turpentine method, suggestion of blue, was positive; Klunge aloin test, same as before, was questionable. 0.009 gram of blood was added to 1 gram of feces, guaiac, turpentine method, pale smoky blue, which faded, was positive; Klunge aloin test was questionable. 0.010 gram of blood was added to 1 gram of feces; guaiac, turpentine method, pale blue, which faded, was positive; Klunge aloin test, same as before, was questionable. 0.015 gram of blood was added to 1 gram of feces; guaiac, turpentine method, deep purple-blue, which faded, was positive; Klunge aloin test, same as before, was questionable.

EXPERIMENT 5.—Exact weight method. 0.002 gram of blood was added to 1 gram of feces; guaiac, turpentine method, no change in color, was negative; Klunge aloin test, no change in color, was negative. 0.005 gram of blood was added to 1 gram of feces; guaiac, turpentine method, light greenish color, which faded, was positive; Klunge aloin test, no change in color, was negative. 0.010 gram of blood was added to 1 gram of feces; guaiac, turpentine method, positive green to blue, which faded, was positive; Klunge aloin test, no change in color, was negative. 0.015 gram of blood was added to 1 gram of feces; guaiac, turpentine method, deep purple blue, which faded slowly, was positive; Klunge aloin test, questionable pinkiness, was questionable.

EXPERIMENT 6.—Exact weight method. 0.004 gram of blood was added to 1 gram of feces; guaiac turpentine method, quick change to light green which gradually changed to smoky blue, was positive; guaiac, dilute peroxide method, quick change to light green, which very quickly faded without a suggestion of blue, was positive; water, guaiac, turpentine method, which gave a beautiful light blue, appeared and gradually faded, was positive; Klunge aloin test, no change in color, was negative. 0.003 gram of blood was added to 1 gram of feces; guaiac, turpentine method, absolutely no change in color, was negative; guaiac, dilute peroxide method, very quick change to grass-green, no suggestion of blue, was positive; water, guaiac, turpentine method, immediate change to greenish-blue which gradually changed to a pale blue having a green quality, was positive; Klunge aloin test, no change in color, was negative. 0.002 gram of blood added to 1 gram of feces; guaiac, turpentine method was absolutely negative; guaiac, dilute peroxide method, no change in color, was negative; water, guaiac, turpentine method, which gave a distinct, quickly appearing flat green with a suggestion of blue, which faded, was positive; Klunge aloin test gave no change, was negative. 0.001 gram of blood added to 1 gram of feces; guaiac, turpentine method, which gave a very delicate green color which faded, was positive; guaiac, dilute peroxide method, gave no change in color, was negative; water, turpentine, guaiac method, which gave a beautiful sky blue which faded, was positive; Klunge aloin test, which gave no change in color, was negative. 0.0005 gram of blood added to 1 gram of feces; guaiac, turpentine method, which gave no change, was negative; guaiac, dilute peroxide method, which gave no change, was negative; water, guaiac, turpentine method, which gave a very faint tinge of green but no blue, faded, was positive.

This patient's stools had been tested for several days previous to the experiment, as a control. They had always given a negative reaction with all tests. The stool with which this experiment was made was soft, formed, and of a light-yellow color.

EXPERIMENT 7.—Exact weight method. 0.004 gram of blood was added to 1 gram of feces; guaiac, turpentine method, light green changing to smoky blue, was positive; guaiac, dilute peroxide of hydrogen, pale green appeared quickly and soon disappeared, with no blue, was positive; water, guaiac, turpentine method, which gave a beautiful blue, which faded, was positive; Klunge aloin test, which gave no change, was negative. 0.003 gram of blood was added to 1 gram of feces; guaiac, turpentine method, which gave no change of color after repeated tests, was negative; guaiac, dilute hydrogen peroxide, which gave a very quick change to a distinct grass green, with no blue, was positive; water, guaiac, turpentine method,which gave an immediate change to greenish-blue, gradually developing a pale-blue color which faded, was positive; Klunge aloin test, which gave no change in color, was negative. 0.002 gram of blood was added to 1 gram of feces; guaiac, turpentine method which gave no change, was negative; guaiac, hydrogen peroxide method, which gave no change, was negative; water, guaiac, turpentine method, which gave a distinct and quickly appearing cloudy green with a suggestion of blue which faded, was positive; Klunge aloin test, no change, was negative. 0.001 gram of blood was added to 1 gram of feces; guaiac, turpentine method, which gave no change of color, was negative; guaiac, dilute hydrogen peroxide method, which gave no change, was negative; water, guaiac, turpentine method, which gave a beautiful sky blue, which gradually appeared and disappeared, was positive; Klunge aloin test was negative. 0.0005 gram of blood was added to 1 gram of feces; guaiac, turpentine method, was negative; guaiac, dilute peroxide method, was negative; water, guaiac, turpentine method, which gave a beautiful delicate sky blue color, which faded, was positive; Klunge aloin test was negative.

The stool with which all these tests were made was of a light-yellow color and thoroughly soft throughout. It was a semiformed stool and the blood could be triturated into it in a most thorough manner.

EXPERIMENT 8.—0.0004 gram of blood, by exact weight, was added to 1 gram of stool and very thoroughly mixed; turpentine, guaiac method (Boas) was absolutely negative; guaiac and dilute hydrogen peroxide method (Boas) was negative; author's water, guaiac, and turpentine method showed a distinct blue ring on the top of the liquid; Klunge aloin reaction was absolutely negative; control was negative.

Experiment 9.—0.00035 gram of blood, by exact weight, was added to 1 gram of feces, and thoroughly mixed; guaiac, turpentine method (Boas) was negative; guaiac, dilute hydrogen peroxide method (Boas) was negative; guaiac, undilute hydrogen peroxide was negative; author's water, guaiac, and turpentine method showed a faint but distinct greenish color in the top of the liquid which quickly appeared and gradually disappeared; Klunge test was negative; control was negative. Below this dilution the water method failed.

Conclusions. From the foregoing experiments the following deductions can be made:

1. The guaiac reaction in all of its modifications is constantly markedly more sensitive than the Klunge aloin reaction. There are times when the aloin reaction seems as sensitive as the guaiac (Experiment 1), but the drop method is not trustworthy.
2. The limit of sensitiveness of the original Boas turpentine method is 0.004 gram of blood per gram of feces. Under certain circumstances it may recognize 0.001 gram of blood per gram of stool (Experiment 6).
3. The limit of sensitiveness of the Boas test when dilute hydrogen peroxide is used is 0.003 gram of blood per gram of stool.
4. The limit of sensitiveness of the author's water and turpentine modification is 0.00035 gram of blood per gram of feces.
5. A color that appears and gradually fades is the crucial test of a positive guaiac reaction.
6. The limit of sensitiveness of the Klunge aloin test is 0.02 gram of blood in 1 gram of feces. Under certain conditions, as in Experiments 4 and 5, a questionable or very faint reaction occurs with 0.015 and 0.004 gram respectively.
7. Most authors agree that it is necessary to obtain a distinct blue color before the reaction can be called positive. Schmilinski,[9] however, is not of this opinion. He regards all shades that develop from a deep green to a reddish brown changing into a violet in which the red is more prominent, and finally the blue predominates as positive as the blue itself. My experience enables me to confirm Schmilinski's contention, as well as to carry it a step farther, and say that all colors that result, from a light distinct tinge of green to green, green to deep green in which at times, but seldom, there is a reddish quality, light violet to blue, or deep blue to indigo blue, are positive evidence that blood is present.
8. The color index may be used as an approximate means of estimating the extent of the hemorrhage. In this series of experiments there was never a change in color with the control, nor was there ever a change in color in the many stools we have examined in the laboratory and marked negative. There was no change,

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[9] Münch. med. Woch., 1903, Nr. 49.

whatsoever, in any experiment until at least 0.00035 gram of blood was added to 1 gram of feces. The first change that was observed was always a light green which became intensified and changed to blue proportionately as the amount of blood per gram was increased. (In one case which showed occult hemorrhages with marked reaction, as the condition subsided the reaction became fainter and fainter until a light green was all that could be obtained, and this eventually disappeared. This is another evidence that the green color is positive of blood.) It may be said that if a light green to a distinct green color develops, a hemorrhage sufficient to mix intimately 0.0005 gram of blood with every gram of feces has occurred; that if a strong reaction is obtained 0.001 gram of blood is present in each gram of feces. As has been shown by the experiments with ingested blood, such a hemorrhage must have amounted to at least 0.5 to 1 gram, provided that it took place in the stomach or jejunum or at some point above these parts.

Series IV.—Blood Ingestion Experiments.

The purpose of this series of experiments was: (1) To determine the amount of human blood that must enter the intestine from the mouth or stomach before a reaction for occult blood will be obtained in the feces. (2) To determine the time that elapses after the ingestion before the reaction is positive. (3) To determine the time that elapses after the appearance of the reaction until it disappears. (4) To determine the comparative sensitiveness of the modifications of the guaiac test and of the aloin test.

To this end blood was taken from the finger of a perfectly healthy person, always from the same person, carefully weighed on a common laboratory balance which weighs quite accurately to tenths of a gram, and quickly mixed with a whisky-glassful of water. The patient was given the contents of the glass to drink, after which it was rinsed and the rinse water swallowed. The stools of these patients were controlled for several days previous to the experiment and were found to be negative. After the ingestion of the blood all bowel movements were saved and the time of their occurrence marked. Sometimes several hours passed before the test was made. It was found, however, that in stools showing reactions for very minute amounts of blood the reaction was not less positive by ageing them for twenty-four hours or more. The results are as follows:

EXPERIMENT 1.—Mr. D. 2 grams of blood was given at 11.45 A.M. First stool passed in fifteen and three-quarter hours; constipated; guaiac, turpentine method (Boas) was negative; guaiac, dilute H_2O_2, negative; guaiac, undilute H_2O_2, negative; author's water, guaiac, and turpentine method, gave a beautiful blue color. Second stool passed in forty-eight hours; guaiac, turpentine method

(Boas) was negative; all other modifications and Klunge aloin test were negative.

EXPERIMENT 2.—Mrs. E. 1 gram of blood was given at 11.30 A.M. First stool twenty-one hours; constipated; guaiac turpentine method (Boas) was negative; all other modifications and Klunge aloin test were negative. Second stool passed in forty-six hours; all tests were negative. Third stool passed in seventy-three hours; all tests were negative.

EXPERIMENT 3.—Mr. A. 1 gram of blood. First stool, passed in eighteen hours, was formed; author's water method and dilute H_2O_2 method were positive; all other methods were negative. Second stool was passed some hours later, time record lost; all methods were negative.

EXPERIMENT 4.—Mrs. C. 0.5 gram of blood was given at 11.30 A.M. First stool was passed in eighteen and one-half hours; slightly constipated; water, guaiac, turpentine method gave a delicate green color, developed slowly, gradually changed to a distinct grass green, and slowly disappeared, was positive; all other methods though repeated several times showed no change of color whatsoever.

EXPERIMENT 5.—Mrs. B. 0.5 gram of blood was given at 11.40 A.M. First stool was passed in seventeen and three-quarter hours, hard; guaiac, water, turpentine method gave a pale-green color, but not a typical reaction; all other methods gave no change of color. Second stool was passed in thirty-nine hours; all methods negative.

EXPERIMENT 6.—Miss S. 0.5 gram of blood was given at 11.20 A.M. First stool was passed in four and one-quarter hours, mushy; all methods were absolutely negative. Second stool was passed in eighteen and one-half hours, soft; all methods were negative.

EXPERIMENT 7.—Miss B. 0.5 gram (fine balance) of blood was given at 3 P.M. First stool was passed in thirteen hours, dark brown and formed; all methods were negative. Second stool was also negative to all tests.

EXPERIMENT 8.—Mr. S. 0.5 gram of blood, fine balance, given at 9.25 A.M. First stool was passed in twenty-one hours, brown, and mushy, all methods were negative. The second stool was also negative.

CONCLUSIONS. 1. In order that a positive reaction for occult blood occur in the stools after a hemorrhage from the œsophagus or the stomach the hemorrhage must amount to 0.5 gram. With such a hemorrhage only a very faint reaction is present. With a gram of blood a decided reaction is always present.

2. The reaction always occurred in the first stool passed after the blood ingestion. The earliest reaction was obtained fifteen and three-quarter hours after ingestion.

3. The reaction was never present in the second stool passed after ingestion.

4. In this series the water, guaiac, turpentine method was

much more sensitive than any of the other modifications. Next in point of sensitiveness was the guaiac and dilute hydrogen peroxide method. The aloin reaction did not take place in any case.

The foregoing study illustrates the peculiar diversity of results that may be obtained with the different occult blood tests, and at times by the same test, when very minute amounts of blood are dealt with. This not only holds true with feces and blood mixtures but also with stools after the ingestion of blood. In the former case it seems as if the character of the stool has something to do with the sensitiveness of the reaction. A stool with a comparatively large water content, that is, a soft, mushy stool, permits of the recognition of smaller amounts of blood than does a pasty or dry stool. Yet there is a limit to the amount of water that may be added to a pasty stool. In the cases of blood ingestion, it was thought that possibly variations in the sensitiveness of the reaction in different individuals was due to variations in their respective digestive power or to variations in the rapidity with which the food is propelled along the gastrointestinal canal. Thus it was thought that in cases of achlorhydria possibly occult blood would be detected in smaller amounts than in cases of hyperchlorhydria, and that in cases of hypermotility it would be recognized in smaller amounts than in cases showing normal motility or stasis. I soon found that there was nothing in this view, and that after digesting small amounts of blood in test-tubes with stomach fluids of strong digestive power the test was as positive in these tubes as in the control. If, on the other hand, the blood was diluted with water, boiled, and then added to the gastric fluid no occult blood test occurred. The action of the digestive juices has practically nothing to do with the hindrance of the occurrence of the reaction, as has been claimed. The reason for the occurrence of occult blood in cases of achlorhydria is because in this condition erosion is very frequently present.

The character of the stool seemed to have little relation to the sensitiveness of the reaction in the ingestion experiments, as it occurred as readily in a hard dry stool as in a soft one. But these peculiarities are doubtless responsible for the diversity of results obtained by various experimenters. Weber found that after 3 grams of uncooked beef a reaction occurred. I have been unable to verify this contention after many trials, not only with Weber's test, but with other modifications which have always proved more sensitive. Joachim found that 3 grams of ingested blood gave the reaction. With the water modification I was able to get a distinct reaction with 0.5 gram of ingested blood, but was also unable to obtain it with any other test. Schloss obtained a positive reaction when he added 0.0008 to 0.0006 gram of blood to a given amount of stool. Kochmann and Boas obtained a reaction with 0.0008 gram, while

Hartmann obtained it with 0.0001 gram. Schloss is inclined to disbelieve Hartmann's contention and I am unable to demonstrate a reaction with these amounts after many trials. From the diversity of results I have obtained in other experiments, being able to detect with the Boas and Weber tests even smaller amounts of blood than many of these observers have, and still smaller amounts at times with the water modification, I am inclined to believe that the results of all of these men are correct, and that it is possible to detect the minute amount reported by Schloss, if the proper conditions present themselves. In the majority of instances the Boas test with turpentine is made much more sensitive by the addition of water before adding the guaiac resin.

THE RECOGNITION OF MINUTE BLOOD-STAINS ON CLOTHING.

For the recognition of small fresh or dried blood-stains on clothing or other fabrics, I have found the following method to be very sensitive. The test so frequently referred to in works on legal medicine, and often described as Taylor's guaiac method, has not proved as sensitive.

1. Cut out the stain with a pair of scissors.
2. Add from 2 to 10 drops of water according to the size of the stain and rub thoroughly with a glass rod.
3. Add from 2 to 10 drops of glacial acetic acid and mix thoroughly.
4. Add to the resulting solution 1 to 2 c.c. of ether.
5. To the ether extract add a few granules of guaiac resin.
6. Add 20 to 30 drops of old water-white turpentine.

If the stain is due to blood a beautiful blue color develops, continues for about five minutes, sometimes longer, and gradually fades.

Much care must be observed in working with small blood-stains. Too much ether and water dilute the hemoglobin. I have been able to demonstrate a beautiful blue reaction with stains several months old, so small and so thin as to be almost unrecognizable —mere light-brown discolorations. The value of so sensitive a test in legal medicine will be apparent. It does not, of course, differentiate human from lower animal blood. If a stain is large the article tested can then be treated according to the directions given for stool examinations.

General Conclusions. 1. Individuals eating an ordinary meat diet seldom give a reaction in the stools with the occult blood tests. If a reaction occurs it is in all probability due to some pathological process in connection with the gastrointestinal tract.

2. For a positive reaction to occur from the ingestion of uncooked meat, 10 grams must have been eaten; usually 20 grams.

3. For a reaction to occur in the stools after a hemorrhage from

the œsophagus or stomach, the hemorrhage must have amounted to at least 0.5 gram. With such a hemorrhage only a faint reaction is obtained. With 1 gram of blood a decided reaction occurs.

4. The reaction always occurs in the first stool passed after the ingestion of pure blood or of food containing free blood. It seldom occurs in the second stool. It may occur as early as ten, and as late as twenty-one, hours after ingestion.

5. The sensitiveness of the guaiac reaction is greatly enhanced if an equal amount of water is added to the ether extract employed, before the addition of the guaiac and turpentine.

6. The diversity of results obtained by various writers and myself, leads to the conclusion that the results obtained by all can be duplicated if the proper conditions present themselves. In other words, when very minute amounts of blood are present a great variety of results will be obtained by all tests, with the same amount of blood, if experiments are made on successive days.

7. The water modification is uniformly more sensitive than the Weber, Boas, or Klunge tests. All of the guaiac tests are more sensitive than the aloin test.

8. A gradually appearing and fading color is the crucial test of a positive reaction. Any color, from a pale green to deep violet, that develops and fades, is positive.

9. In medicolegal cases, when the question arises as to the nature of minute stains on articles of clothing, paper, etc., the water modification of the guaiac reaction will be found to be more sensitive than the Taylor method, so frequently referred to in works on legal medicine, and its application is very simple.

VARICOSE ANEURYSM OF THE AORTA AND SUPERIOR VENA CAVA.

By Charles Cary, M.D.,

PROFESSOR OF CLINICAL MEDICINE, UNIVERSITY OF BUFFALO, BUFFALO, NEW YORK.

On Monday, February 25, 1905, on entering the wards of the Buffalo General Hospital, my attention was at once attracted by the unusual and startling appearance of a patient occupying one of the near beds. He was a large man, in a recumbent position, with a most striking cyanosis of the head, neck, hands, and part of the chest, exposed by his open shirt. He was not blue, but his color was blue-black, of a degree which cannot well be exaggerated. His face was swollen, his eyes closed by œdematous lids. On approaching him I was surprised to find him conscious, and not as distressed and dyspneic as his appearance would lead one to